

PATENT ABSTRACTS OF JAPAN

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(71)Applicant : KYOCERA CORP

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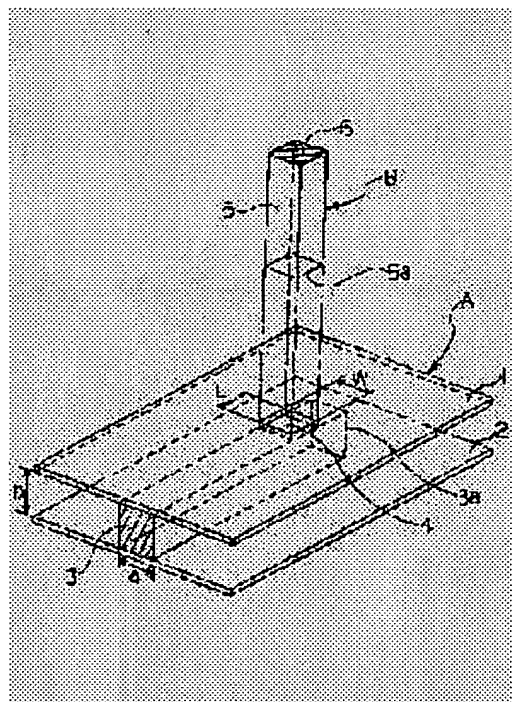
(72)Inventor : SATO AKINORI

(54) CONNECTION STRUCTURE BETWEEN NRD GUIDE AND DIELECTRIC WAVEGUIDE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a connection structure between a nonradioactive dielectric line NRD guide and a dielectric waveguide by which transmission with a small loss is attained even for a millimeter wave band of ≥ 30 GHz.

SOLUTION: The connection structure connects an NRD guide A formed by placing a dielectric line 3 between 1st and 2nd flat conductors 1, 2 to a dielectric waveguide B formed by filling a dielectric material in a conductor pipe, an open hole 4 is made for the conductor plate 1 at a position at which an electric field of a standing wave in the LSM mode is maximized in the NRD guide A, the open hole 4 and an open termination 5a of the dielectric waveguide B are connected or an open hole is formed



for a side wall at a position placed from an end 5b of the dielectric waveguide B by $1/2$ wavelength with respect to the waveguide wavelength and the open hole 4 of the NRD guide A and the open hole of the dielectric waveguide B are connected.

LEGAL STATUS

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20.05.2002

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CLAIMS

[Claim(s)]

[Claim 1] the 1st and the 2nd are monotonous -- a conductor -- the NRD guide which comes to arrange a dielectric wire way in between, and a conductor -- said 1st conductor of the part where the electric field of the standing wave in the LSM mode of said NRD guide become max in the structure for connecting the dielectric waveguide with which it filled up with the dielectric in the pipe -- the connection structure of the NRD guide characterized by to prepare puncturing in a plate and to connect this puncturing and the open trailer of said dielectric waveguide to it, and a dielectric waveguide.


[Claim 2] In the structure for connecting the dielectric waveguide with which it filled up with the dielectric in the pipe the 1st and the 2nd are monotonous -- a conductor -- the NRD guide which comes to arrange a dielectric wire way in between, and a conductor -- said 1st conductor of the part where the electric field of the standing wave in the LSM mode of said NRD guide become max, while preparing puncturing in a plate Connection structure of a NRD guide and a dielectric waveguide characterized by preparing puncturing in the side attachment wall of said dielectric waveguide, and connecting puncturing of said NRD guide, and puncturing of said dielectric waveguide to it.

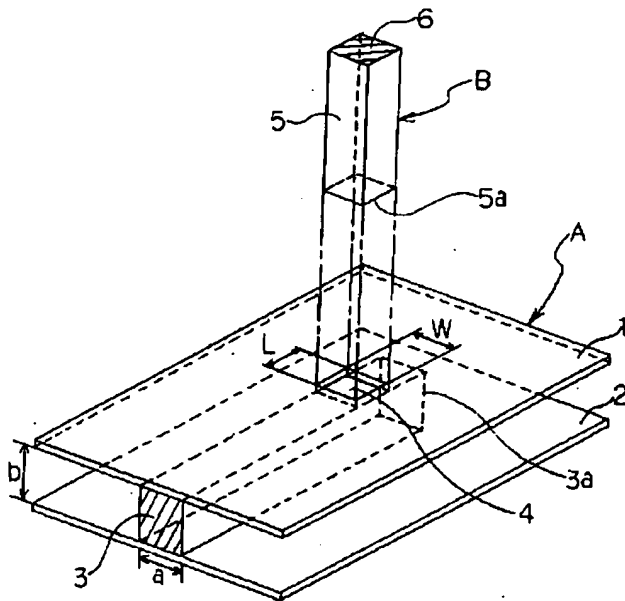
[Claim 3] Connection structure of a NRD guide and a dielectric waveguide according to claim 2 where puncturing formed in the side attachment wall of said dielectric waveguide is formed in the 1/2-wave die-length location of the guide wave length from the trailer of said dielectric waveguide.

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Drawing selection **Representative drawing** 



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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention is included in a millimeter wave integrated circuit etc., and relates to the structure for connecting the NRD guide and dielectric waveguide which are used as an object for transmission of a RF signal.

[0002]

[Description of the Prior Art] the former -- a dielectric wire way -- one pair of conductors -- it is known that the nonradioactive dielectric wire way (henceforth a NRD guide) which consists of simple structure pinched with the plate will use as one of the transmission lines of a RF signal. And when including this NRD guide in a wiring substrate etc., it is indispensable on a circuit design to connect this NRD guide with other transmission lines for RFs, and it is important to connect without degradation of a transmission characteristic in that case.

[0003] Then, the structure for connecting with a microstrip line is proposed as the NRD guide as connection structure with other RF transmission lines. The general structure is shown in drawing 6. according to drawing 6 -- the conductor of a pair -- the conductor in the NRD guide with which the dielectric wire way 3 was arranged among plates 11 and 12 -- to a plate 11 By forming the slot hole 13, and laying the substrate with which the central conductor 15 was formed in dielectric substrate 14 front face in the front face of the slot hole 13 so that the slot hole 13 and the trailer of a central conductor 15 may become position relation a NRD guide and a microstrip line -- the conductor of a NRD guide -- the conductor prepared in the plate -- it connects electromagnetic through the slot hole 13 which was able to be opened in the plate.

[0004]

[Problem(s) to be Solved by the Invention] However, since the frequency of a RF signal became large with a millimeter wave band 30GHz or more in a circuit design in a microstrip line in the transmission loss itself, the above-mentioned connection structure was unsuitable for the circuit board whose signal frequency is 30GHz or more.

[0005] Instead of this microstrip line, the dielectric waveguide is known as a small track of transmission loss like the NRD guide also to the millimeter wave 30GHz or more, and it is necessary to use a dielectric waveguide also in a circuit design. However, there was no report about the connection structure of a NRD guide and a dielectric waveguide until now.

[0006] Therefore, this invention aims at offering the connection structure of the NRD guide and dielectric waveguide in which small transmission of loss is possible also with a millimeter wave band 30GHz or more.

[0007]

[Means for Solving the Problem] as for this invention person, the 1st and the 2nd are monotonous -- a conductor -- with the NRD guide which comes to arrange a dielectric wire way in between The result of having repeated examination about the structure where transmission loss is [a dielectric waveguide] small connectable, said 1st conductor of the part where the horizontal component of the electric field of

the signal in a NRD guide serves as max -- preparing puncturing in a plate and connecting this puncturing and the open section of a dielectric waveguide to it -- Or it found out that said purpose was attained by preparing puncturing in the side attachment wall of the 1/2-wave die-length location of the guide wave length from the termination of said dielectric waveguide, and connecting puncturing of said NRD guide, and puncturing of said dielectric waveguide.

[0008]

[Embodiment of the Invention] Hereafter, the NRD guide and dielectric-waveguide connection structure of this invention are explained based on drawing 1 and drawing 2 which are the outline perspective view.

[0009] as shown in drawing 1 and drawing 2, the pair of the NRD guide A of this invention is parallel -- monotonous -- the dielectric wire way 3 of axb is arranged for the cross section between a conductor 1 and 2, and the edge has become open trailer 3'. In the NRD guide A of such structure, the standing wave of the electric field by LSM mode as shown in drawing 3 arises.

[0010] the conductor in the part of P1, P2, P3, or P4 in a part with the electric field of this standing wave strong as an object for connection with a dielectric waveguide B in this invention, i.e., drawing 3, -- the puncturing 4 centering on each part of P1-4 is formed in a plate 1. It is desirable to form puncturing 4 in the part of P1 or P2 from the point of a circuit design with a dielectric waveguide B.

[0011] in addition, a conductor -- little connection of loss with a dielectric waveguide is obtained by embedding the dielectric which has a dielectric constant comparable as the dielectric wire way 3 in the puncturing 4 of a plate 1.

[0012] On the other hand, a cross section is formed with the tubing 5 of a rectangle-like metal, and, as for the dielectric waveguide B, the dielectric 6 is embedded in the interior.

[0013] a conductor [in / in the above-mentioned NRD guide A and a dielectric waveguide B / the NRD guide A] -- it connects through the puncturing 4 prepared in the plate 1. As the approach of connection, as shown in drawing 1, open trailer 5a and puncturing 4 are connected for the edge of a NRD guide. Moreover, loss is [a dielectric waveguide B] small connectable with the NRD guide A by forming puncturing 7 in some side attachment walls 4 of a dielectric waveguide B as other approaches, as shown in the perspective view of drawing 2, adjusting the puncturing 4 by the side of the NRD guide A, and the puncturing 7 by the side of a dielectric waveguide B, and connecting.

[0014] In addition, as for puncturing 7, in the connection method of drawing 2, it is desirable to form the distance x from termination 5b of a dielectric waveguide B in the 1/2-wave die-length location of the guide wave length of a dielectric waveguide B.

[0015] Moreover, small connection of loss is possible by forming with the dielectric which has a dielectric constant comparable as the dielectric wire way 3 in the NRD guide A as a dielectric 6 in a dielectric waveguide B.

[0016] The configuration of the puncturing 4 by the side of the NRD guide A may have the shape of a circle configuration besides the shape of drawing 1 and a rectangle as shown in drawing 2 with the width of face (W) of same extent as the die length below one half of the guide wave length of a NRD guide (L), and the dielectric strip of a NRD guide, and a long hole.

[0017] As a dielectric used for the connection structure of the NRD guide A of this invention, and a dielectric waveguide B, well-known dielectric materials, such as organic system dielectric materials besides the ceramics and organic - inorganic multicomputer system dielectric materials, are used.

[0018]

[Example] The copper plate with an example 1 thickness of 1mm was placed in parallel at intervals of 1.8mm, puncturing of width of face of 0.8mm which has a core in the location of 3.3mm, and a die-length 1.2mm rectangle was opened in the metal plate from the open trailer of the NRD guide with which a cross-section configuration is formed by placing the dielectric wire way of width of face of 0.8mm, height of 1.8mm, and specific inductive capacity 4.8 between metal plates, and it was filled up with the dielectric of specific inductive capacity 4.8 in the puncturing.

[0019] And to this puncturing, it had the same cross-section configuration as a puncturing configuration, and specific inductive capacity connected the dielectric waveguide with which it filled up with the

dielectric of 4.8 in the metallic conduit. The transmission characteristic between a NRD guide and a dielectric waveguide (S21) was measured with the network analyzer about the connection structure by this configuration, and that result was shown in drawing 5. The good transmission characteristic which has the peak of -0.6 (dB) in about 78GHz was shown so that clearly from the result of drawing 5.

[0020] To the NRD guide in which puncturing of example 2 example 1 was formed, it had a 0.6mmx1.2mm cross-section configuration, and specific inductive capacity connected the dielectric waveguide with which it filled up with the dielectric of 4.8. Puncturing of a NRD guide and puncturing of the same configuration were formed in the side attachment wall with which the distance of the trailer of a dielectric waveguide and a center position becomes connection with 1.34mm, and the double door hole was connected to it. And the transmission characteristic was evaluated like the example 1 and the result was shown in drawing 6. As shown in drawing 6, in the 74-80GHz field, transmission loss showed the good property smaller than -1.0dB.

[0021]

[Effect of the Invention] according to [as explained in full detail above] this invention -- a NRD guide and a dielectric waveguide -- the conductor of a NRD guide -- connection by the low insertion loss is attained by connecting with a dielectric waveguide through puncturing prepared in the specific part of a plate.

[Translation done.]

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MEANS

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EXAMPLE

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is a decomposition perspective view for explaining an example of the connection structure of the NRD guide of this invention, and a dielectric waveguide.

[Drawing 2] It is a decomposition perspective view for explaining other examples of the connection structure of the NRD guide of this invention, and a dielectric waveguide.

[Drawing 3] It is a top view for explaining the electric-field distribution in the NRD guide in this invention.

[Drawing 4] It is drawing showing the transmission characteristic by the connection structure of drawing 1 in this invention.

[Drawing 5] It is drawing showing the transmission characteristic by the connection structure of drawing 2 in this invention.

[Drawing 6] It is an outline perspective view for explaining the connection structure of the NRD guide and microstrip line in the former.

[Description of Notations]

A NRD guide

B Dielectric waveguide

1 and 2 monotonous -- conductor

3 Dielectric Wire Way

4 Seven Puncturing

5 Conductor Tube Wall

5a An open trailer

5b Trailer

6 Dielectric

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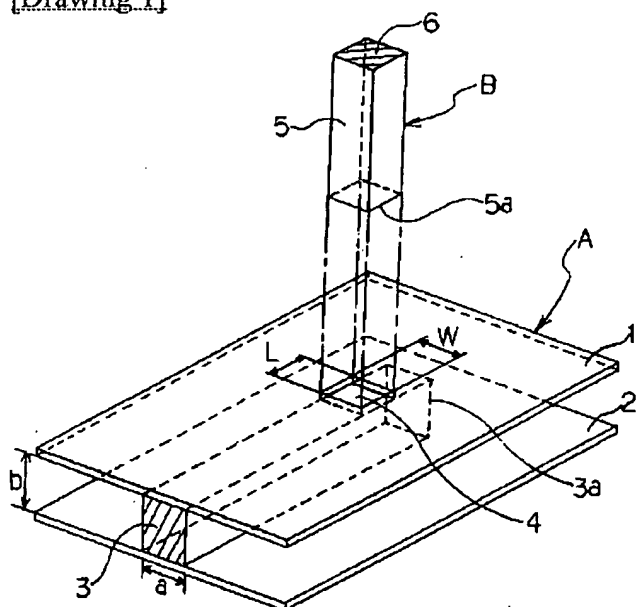
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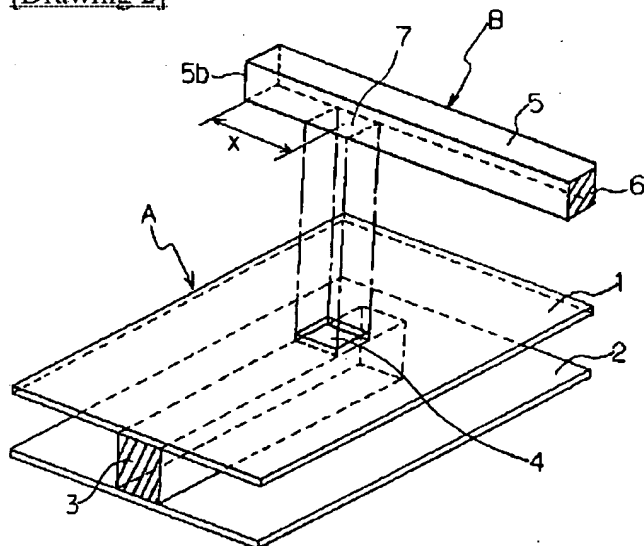
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DRAWINGS

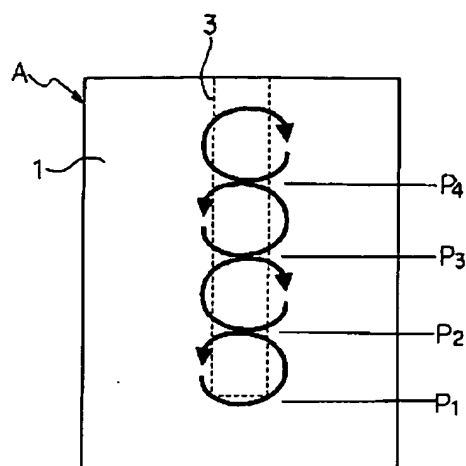
[Drawing 1]



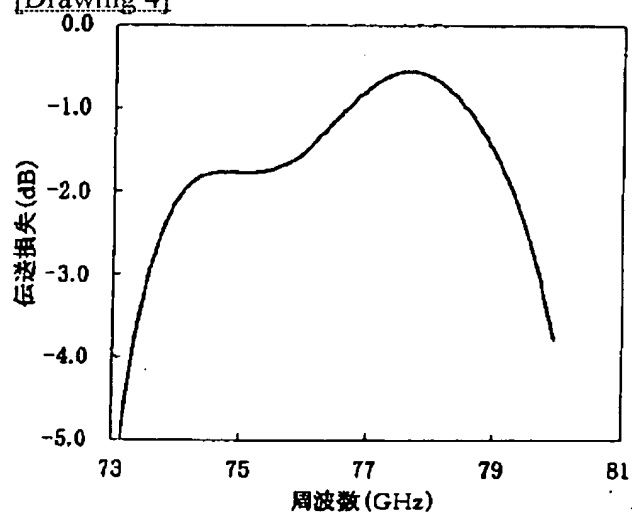
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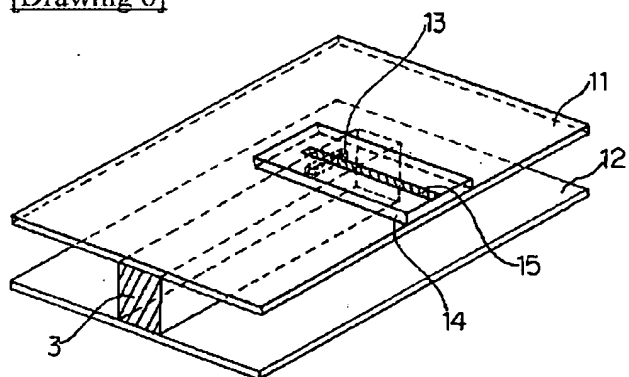
[Drawing 3]



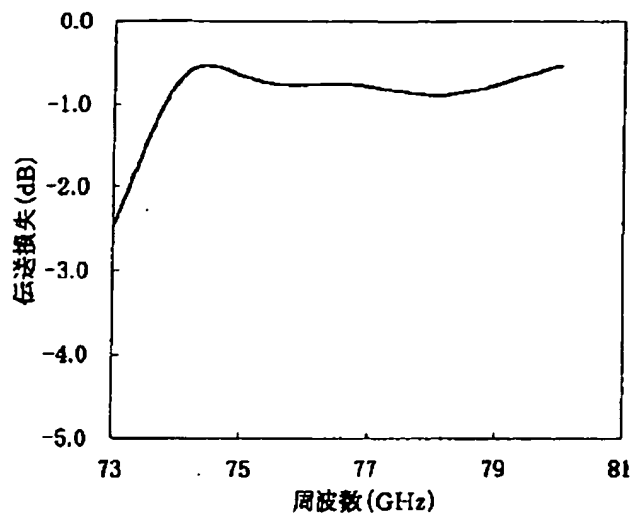
[Drawing 4]



[Drawing 6]



[Drawing 5]



[Translation done.]

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(71) 出願人 000006633

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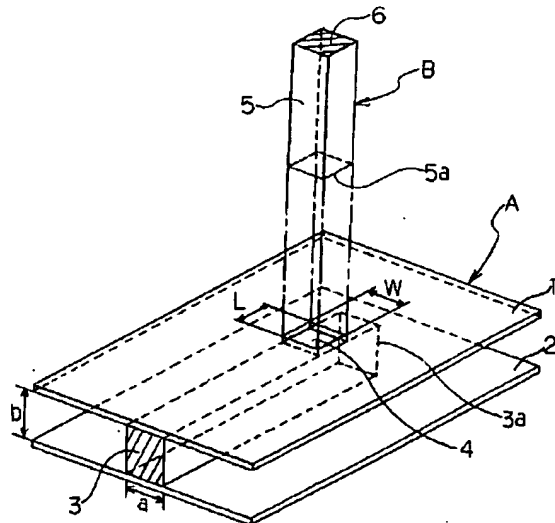
Fターム(参考) 5J014 DA03 HA06

(54) 【発明の名称】 NRDガイドと誘電体導波管との接続構造

(57) 【要約】

【課題】 30GHz以上のミリ波帯でも、損失の小さい伝送が可能なNRDガイドと誘電体導波管との接続構造を提供する。

【解決手段】 第1および第2の平板導体1、2間に誘電体線路3を配設してなるNRDガイドAと、導体内に誘電体が充填された誘電体導波管Bとを接続する構造であって、NRDガイドA内のLSMモードの定在波の電界が最大になる箇所の第1の導体板1に開孔4を設け、開部4と誘電体導波管Bの開放終端部5aとを接続するか、あるいは誘電体導波管Bの終端5bから管内波長の1/2波長長さ位置の側壁に開孔7を設け、NRDガイドAの開孔4と、誘電体導波管Bの開孔7とを接続する。



【特許請求の範囲】

【請求項1】第1および第2の平板導体間に誘電体線路を配設してなるNRDガイドと、導体内に誘電体が充填された誘電体導波管とを接続するための構造において、前記NRDガイドのLSMモードの定在波の電界が最大になる箇所の前記第1の導体板に開孔を設け、該開孔と前記誘電体導波管の開放終端部とを接続することを特徴とするNRDガイドと誘電体導波管の接続構造。

【請求項2】第1および第2の平板導体間に誘電体線路を配設してなるNRDガイドと、導体内に誘電体が充填された誘電体導波管とを接続するための構造において、前記NRDガイドのLSMモードの定在波の電界が最大になる箇所の前記第1の導体板に開孔を設けるとともに、前記誘電体導波管の側壁に開孔を設け、前記NRDガイドの開孔と、前記誘電体導波管の開孔とを接続することを特徴とするNRDガイドと誘電体導波管の接続構造。

【請求項3】前記誘電体導波管の側壁に形成される開孔が、前記誘電体導波管の終端部から管内波長の1/2波長長さ位置に形成される請求項2記載のNRDガイドと誘電体導波管の接続構造。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、ミリ波集積回路等に組み込まれ、高周波信号の伝送用として用いられるNRDガイドと誘電体導波管とを接続するための構造に関する。

【0002】

【従来技術】従来より、誘電体線路を1対の導体板によって挟持した単純な構造からなる非放射型誘電体線路（以下、NRDガイドという。）が高周波信号の伝送線路の1つとして用いることが知られている。そして、このNRDガイドを配線基板などに組入れる場合、回路設計上、このNRDガイドを他の高周波用伝送線路と接続することが必要不可欠であり、その場合、伝送特性の劣化なく接続することが重要である。

【0003】そこで、他の高周波伝送線路との接続構造として、NRDガイドと、マイクロストリップ線路とを接続するための構造が提案されている。その一般的な構造を図6に示す。図6によれば、1対の導体板11、12の間に誘電体線路3が配設されたNRDガイドにおける導体板11に、スロット孔13を形成し、そのスロット孔13の表面に、誘電体基板14表面に中心導体15が形成された基板をスロット孔13と中心導体15の終端部とが所定の位置関係になるように載置することにより、NRDガイドと、マイクロストリップ線路とをNRDガイドの導体板に設けられた導体板に開けられたスロット孔13を介して電磁的に接続するものである。

【0004】

【発明が解決しようとする課題】しかしながら、回路設

計において高周波信号の周波数が30GHz以上のミリ波帯では、マイクロストリップ線路では伝送損失自体が大きくなるために、上記接続構造は信号周波数が30GHz以上である回路基板には不向きであった。

【0005】このマイクロストリップ線路に代わり、30GHz以上のミリ波に対してもNRDガイドと同様に伝送損失の小さい線路として誘電体導波管が知られており、回路設計においても誘電体導波管を用いることが必要となる。しかしながら、NRDガイドと誘電体導波管との接続構造についてはこれまで全く報告がなかった。

【0006】従って、本発明は、30GHz以上のミリ波帯でも、損失の小さい伝送が可能なNRDガイドと誘電体導波管との接続構造を提供することを目的とするものである。

【0007】

【課題を解決するための手段】本発明者は、第1および第2の平板導体間に誘電体線路を配設してなるNRDガイドと、誘電体導波管とを伝送損失を小さく接続できる構造について検討を重ねた結果、NRDガイド内の信号の電界の水平成分が最大となる箇所の前記第1の導体板に開孔を設け、該開孔と誘電体導波管の開放断面とを接続すること、あるいは前記誘電体導波管の終端から管内波長の1/2波長長さ位置の側壁に開孔を設け、前記NRDガイドの開孔と、前記誘電体導波管の開孔とを接続することによって、前記目的が達成されることを見いだした。

【0008】

【発明の実施の形態】以下、本発明のNRDガイドと誘電体導波管接続構造について、その概略斜視図である図1、図2をもとに説明する。

【0009】図1、図2に示すように、本発明のNRDガイドAは、1対の平行平板導体1、2間に、断面がa×bの誘電体線路3が配設されており、端部は開放終端部3'となっている。このような構造のNRDガイドAにおいては、図3に示すようなLSMモードによる電界の定在波が生じる。

【0010】本発明においては、誘電体導波管Bとの接続用として、この定在波の電界の強い部分、即ち、図3におけるP1、P2、P3、P4のいずれかの箇所における導体板1に、P1～4の各箇所を中心とする開孔4を設ける。誘電体導波管Bとの回路設計の点からは、P1またはP2の箇所に開孔4を設けることが望ましい。

【0011】なお、導体板1の開孔4内には、誘電体線路3と同程度の誘電率を有する誘電体を埋め込むことによって、誘電体導波管との損失の少ない接続が得られる。

【0012】一方、誘電体導波管Bは、断面が矩形状の金属の管5によって形成され、その内部には、誘電体6が埋め込まれている。

【0013】上記NRDガイドAと誘電体導波管Bと

は、NRDガイドAにおける導体板1に設けられた開孔4を介して接続される。接続の方法としては、図1に示すように、NRDガイドの端部を開放終端部5aと開孔4とを接続する。また、他の方法としては、図2の斜視図に示すように誘電体導波管Bの側壁4の一部に開孔7を形成し、NRDガイドA側の開孔4と誘電体導波管B側の開孔7とを整合させて接続することにより、NRDガイドAと誘電体導波管Bとを損失を小さく接続することができる。

【0014】なお、図2の接続方法においては、開孔7は、誘電体導波管Bの終端部5bからの距離xが、誘電体導波管Bの管内波長の $1/2$ 波長長さ位置に形成されることが望ましい。

【0015】また、誘電体導波管B内の誘電体6としては、NRDガイドAにおける誘電体線路3と同程度の誘電率を有する誘電体により形成することにより損失の小さい接続が可能である。

【0016】NRDガイドA側の開孔4の形状は、NRDガイドの管内波長の半分以上の長さ(L)とNRDガイドの誘電体ストリップと同じ程度の幅(W)を持つ、図1、図2に示すような矩形状の他、円形状、長孔状であってもよい。

【0017】本発明のNRDガイドAと誘電体導波管Bとの接続構造に用いられる誘電体としては、セラミックスの他、有機系誘電体材料、有機-無機複合系誘電体材料などの周知の誘電体材料が用いられる。

【0018】

【実施例】実施例1

厚さ1mmの銅板を1.8mmの間隔で平行に置き、断面形状が幅0.8mm、高さ1.8mm、比誘電率4.8の誘電体線路を金属板間に置くことで形成されるNRDガイドの開放終端部から3.3mmの位置に中心を持つ幅0.8mm、長さ1.2mmの矩形の開孔を金属板に開け、その開孔内には比誘電率4.8の誘電体を充填した。

【0019】そして、この開孔に対して、開孔形状と同じ断面形状を持ち、比誘電率が4.8の誘電体が金属管内に充填された誘電体導波管を接続した。この構成による接続構造についてネットワークアナライザによってNRDガイドと誘電体導波管間の伝送特性(S21)を測定し、その結果を図5に示した。図5の結果から明らかに、約78GHzにおいて-0.6(dB)のビ

ークを有する良好な伝送特性を示した。

【0020】実施例2

実施例1の開孔を形成したNRDガイドに対して、0.6mm×1.2mmの断面形状を持ち、比誘電率が4.8の誘電体が充填された誘電体導波管を接続した。接続には、誘電体導波管の終端部と中心位置との距離が1.34mmとなる側壁にNRDガイドの開孔と同一形状の開孔を形成し、両開孔を接続した。そして、実施例1と同様にして伝送特性を評価し、その結果を図6に示した。図6に示すように、74~80GHz領域において、伝送損失が-1.0dBよりも小さい良好な特性を示した。

【0021】

【発明の効果】以上詳述した通り、本発明によれば、NRDガイドと誘電体導波管とをNRDガイドの導体板の特定箇所に設けた開孔を介して誘電体導波管と接続することにより、低い挿入損失での接続が可能になる。

【図面の簡単な説明】

【図1】本発明のNRDガイドと誘電体導波管の接続構造の一例を説明するための分解斜視図である。

【図2】本発明のNRDガイドと誘電体導波管の接続構造の他の例を説明するための分解斜視図である。

【図3】本発明におけるNRDガイド内の電界分布を説明するための平面図である。

【図4】本発明における図1の接続構造による伝送特性を示す図である。

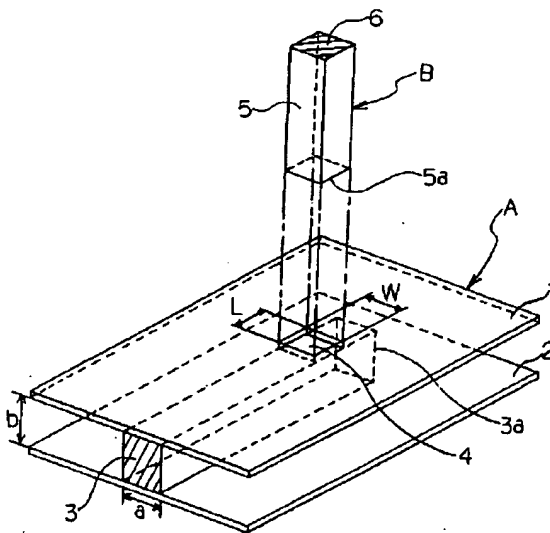
【図5】本発明における図2の接続構造による伝送特性を示す図である。

【図6】従来におけるNRDガイドとマイクロストリップ線路との接続構造を説明するための概略斜視図である。

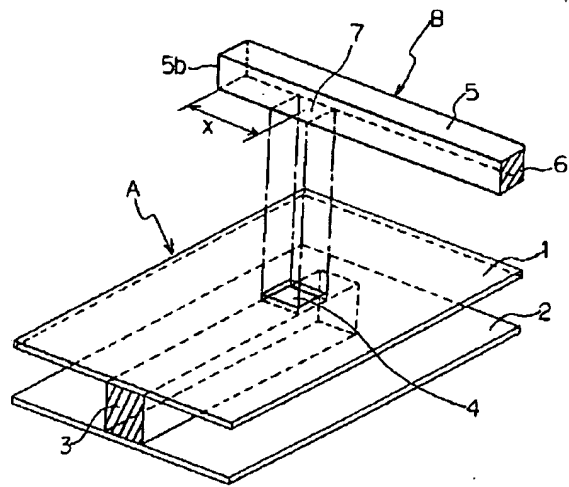
【符号の説明】

- A NRDガイド
- B 誘電体導波管
- 1, 2 平板導体
- 3 誘電体線路
- 4, 7 開孔
- 5 導体管壁
- 5a 開放終端部
- 5b 終端部
- 6 誘電体

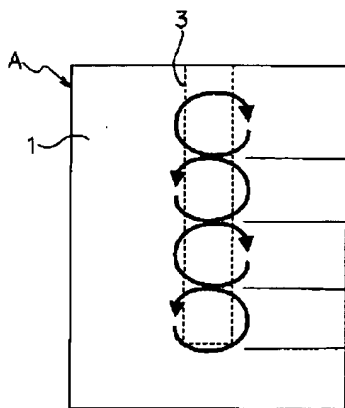
【図1】



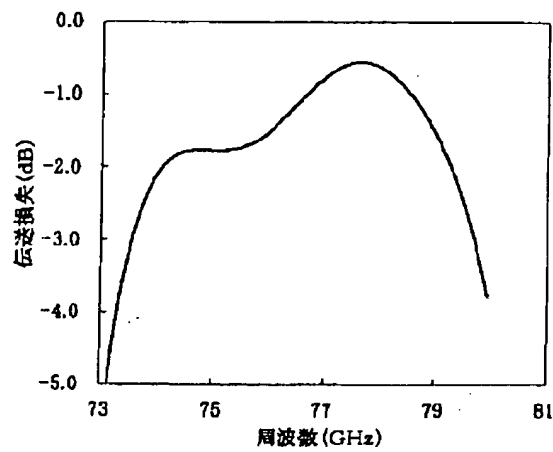
【図2】



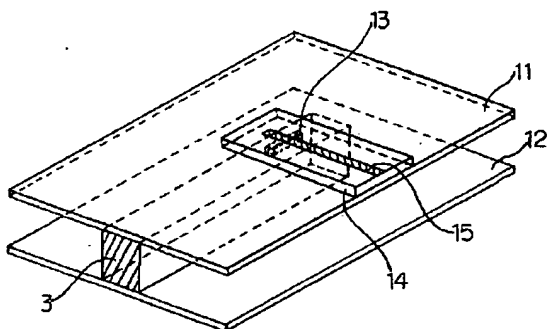
【図3】



【図4】



【図6】



【図5】

